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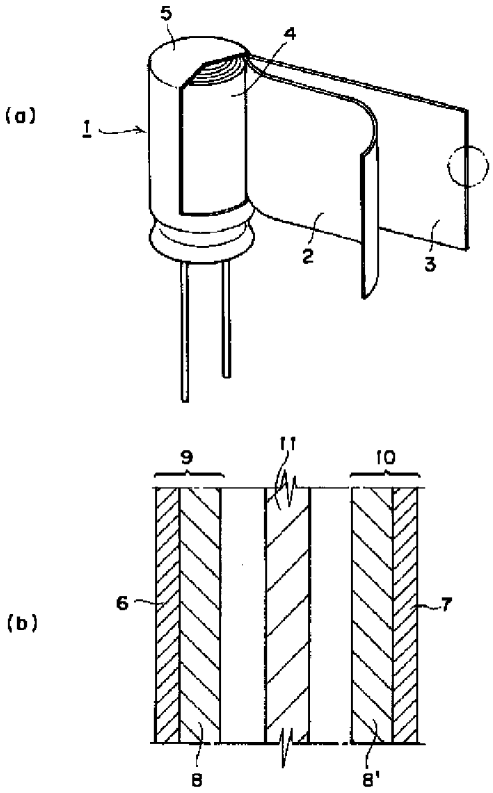
要約

(57)【要約】
【課題】 従来のものと比べてエネルギー密度および出力密度のいずれの特性も著しく改善されたエネルギー貯蔵素子を提供。
【解決手段】 エネルギー貯蔵素子は、セパレータを介して対向する2つの電極と、該電極が浸された電解液とを有する電気二重層キャパシタを複数積層させたキャパシタ積層体を備える。



請求の範囲

【特許請求の範囲】
【請求項1】セパレータを介して対向する2つの電極と、該電極が浸された電解液とを有する電気二重層キャパシタを複数積層させたキャパシタ積層体を備え、前記キャパシタ積層体は、渦巻き状に巻回された複数の電気二重層キャパシタからなることを特徴とするエネルギー貯蔵素子。
【請求項2】前記電解液は、非水溶媒系の有機電解液であることを特徴とする請求項1に記載のエネルギー貯蔵素子。
【請求項3】前記電解液は、水系の水溶液電解液であることを特徴とする請求項1に記載のエネルギー貯蔵素子。
【請求項4】前記2つの電極の各々は、カーボン電気二重層電極であることを特徴とする請求項1ないし3のいずれか一項に記載のエネルギー貯蔵素子。
【請求項5】前記2つの電極の各々は、電気化学キャパシタ電極であることを特徴とする請求項1ないし3のいずれか一項に記載のエネルギー貯蔵素子。
【請求項6】前記電気化学キャパシタ電極は、$Ru(OH)_3 \cdot XH_2O$の式で表されるルテニウム水酸化物を担持したカーボンシート電極であることを特徴とする請求項5に記載のエネルギー貯蔵素子。
【請求項7】前記キャパシタ積層体の断面形状は、円筒形、楕円形、および多角形のいずれか一つの形状であることを特徴とする請求項1ないし6のいずれか一項に記載のエネルギー貯蔵素子。

詳細な説明

【発明の詳細な説明】
【0001】
【発明の属する技術分野】本発明は、電気エネルギーの貯蔵に関する分野に属し、特に電気自動車用電池とのハイブリッド電源として注目されているエネルギー貯蔵素子、燃料電池や太陽電池等と組み合わせて使用可能なエネルギー貯蔵素子、さらに非常用電源あるいはICやメモリのバックアップ電源として使用可能なエネルギー貯蔵素子に関する。

【0002】
【従来の技術】近年、地球規模で取り組まなければならない課題としてエネルギーの有効利用と環境破壊の防止である。特に、自動車産業の発展に伴う化石燃料の大量消費および排気ガスによる大気汚染等の環境破壊は深刻な問題となっている。このような問題は一企業や一国レベルで解決できる問題ではなく地球規模での対策が日に日に求められている。
【0003】少なくとも日本を含む先進国は、エネルギーの有効利用、省エネルギー技術の見直しと新たな技術開発、さらに環境破壊防止への取り組みを内外、官民を問わず進めている。そのような技術開発の一例として、近年注目されているのがガソリンエンジンと電気モータとを組み合わせたハイブリッド電気自動車や電気モータのみによって駆動する電気自動車の開発、都市部での夜間電力の有効活用を目指した氷蓄熱技術の開発、環境性に優れる発電効率の高い燃料電池の開発、さらには太陽エネルギーを利用した太陽電池の開発を挙げることができる。
【0004】ところで、ハイブリッド電気自動車や電気自動車では、バッテリーが電気エネルギーの貯蔵電源として用いられる。しかし、バッテリーはエネルギー密度特性には優れるものの出力密度特性は十分とは言えず、バッテリーより出力密度特性に優れるキャパシタをバッテリーと組み合わせて電気自動車の電源システムに用いることが提案されている。
【0005】いわゆる電気二重層キャパシタは、電極と電解液との界面に生ずる電気二重層の大きな容量を利用し、この二重層の電荷を電池の充放電と同様に出し入れするものである。電解液には有機溶媒系のものと水溶液系のものとがある。
【0006】図3は、従来より公知の代表的な円筒型の電気二重層キャパシタの部分分解斜視図である。このキャパシタは、耐食性の電解液を使用し、一対の電極を巻回して円筒形にしたものである。すなわち、活性炭のような表面積の大きな材料とフッ素樹脂等の結着剤とで成形した薄膜状の陽極31と同様にして成形された薄膜状の陰極32との間に、ポリエチレンまたはポリプロピレン製の多孔膜からなるセパレータ33を挟持させた薄膜状電極積層体を巻回している。このように渦巻き状にすることで、キャパシタ内に占める電極の表面積が大きくなり、それに反比例してキャパシタの内部抵抗が小さくなる。その結果、イオン伝導度が水溶液系電解液に比較して桁で大きい非水溶媒系電解液でも電解液に用いることができる。この非水溶媒系電解液の溶媒の分解電圧は水溶液系電解液の溶媒である水の分解電圧よりも一般に高いので、非水溶媒系電解液を用いたキャパシタは水溶液系電解液を用いたキャパシタよりもその分エネルギー密度を大きくすることができる。ところで、円筒形ではなく平板積層型のキャパシタも従来から知られている。しかし平板積層型のキャパシタは、キャパシタ電圧がセルの積層数に比例して大きくなる一方で、電解液による内部抵抗も積層数に比例して大きくなってしまう。このため平板積層型キャパシタでは、イオン伝導度が水溶液系電解液に比較して桁で小さい非水溶媒系電解液を用いることができないため、主に水溶液系電解液が用いられ、それによって多数セルの一括化が可能となる。しかし、この平板積層型はすでに述べたように非水溶媒系電解液よりも水溶液系電解液の分解電圧が低いため、その分、原理的にはエネルギー密度が小さくなるという問題点を有する。
【0007】このように、従来のキャパシタはその電解液が水溶液系か非水溶媒液系であるかによって、キャパシタの構造が決まると言える。この巻き取り型と平板積層型のそれぞれの特徴を比較すると次のようになる。すなわち、巻き取り型ではすでに述べたように非水溶媒液系電解液が用いられるため、電解液による金属製円筒缶（一般にはアルミニウムが円筒缶の材料に用いられる）の腐食の心配がなく、またシールは円筒缶を機械的にかしめて封入する方法により容易に達成される。逆に水溶液系電解液は金属円筒缶を腐食するためこれは通常用いられない。他方、水溶液系電解液は非水溶媒液系電解液に比較して桁違いに安く、それを用いた平板積層型は複数セルを積層するため単セル型の円筒型を同数電気的に直列接続したものに比較して部材点数が少なく、その分も低コストとなることが期待できる。しかし、水溶液系電解液は腐食性があるため電極にはアルミニウム等の金属電極は用いることができず、通常、カーボンが用いられる。また、電解液のシールは積層セル丸ごとの樹脂モールド化が通常なされる。したがって、コスト的にはどちらのタイプが有利かは明瞭ではない。また、平板積層型は高電圧かつ大電流の高出力が原理的に期待できるが、巻き取り型（円筒型）はそれを複数電気的に直列接続することになり、電解液による内部抵抗は電極の大面積化で対策済みではあるけれども、電気リード線同士の接続抵抗が増大して、平板積層型に比較して巻き取り型（円筒型）を複数個接続させた場合では高出力密度は期待できなくなる。
【0008】

【発明が解決しようとする課題】このように、従来の円筒型キャパシタと平板積層型キャパシタとは、どちらの場合にも一長一短がある。すなわち電解液の分解電圧が高い円筒型キャパシタに適用される電極およびセパレータの積層構造は、エネルギー密度は高いが電解液の抵抗が大きいため平板積層化は困難であり、また該円筒型キャパシタを複数接続させる構成としても電極リード線同士の接続抵抗増大等で出力密度が劣る。一方、平板積層型キャパシタは出力密度では円筒型キャパシタより優れるが、エネルギー密度は電解液の分解電圧が低い分、円筒型のものよりも劣る。

【0009】したがって、本発明は上記課題を解決し、エネルギー密度および出力密度のいずれのも原理的に優れる新規のエネルギー貯蔵素子を提供することを目的とする。

【0010】

【課題を解決するための手段】上記課題を解決するために、本発明にもとづくエネルギー貯蔵素子は、セパレータを介して対向する2つの電極と、該電極が浸された電界液とを有する電気二重層キャパシタを複数積層させたキャパシタ積層体を備え、前記キャパシタ積層体は、渦巻き状に巻回された複数の電気二重層キャパシタからなる。

【0011】好ましくは、前記電解液は非水溶媒系の有機電解液または水系の水溶液電解液である。

【0012】好ましくは、前記2つの電極の各々は、カーボン電気二重層電極である。

【0013】好ましくは、前記2つの電極の各々は、電気化学キャパシタ電極である。

【0014】好ましくは、前記電気化学キャパシタ電極は、$Ru(OH)_3 \cdot XH_2O$の式で表されるルテニウム水酸化物を担持したカーボンシート電極である。

【0015】好ましくは、前記キャパシタ積層体の断面形状は、円筒形、楕円形、および多角形のいずれか一つの形状である。

【0016】複数の電極対を巻き取ることにより複数セルの積層化ができ、かつ巻き取りにより電極の大面積化が維持される一方で、内部抵抗の増大が抑制される。その結果、原理的にエネルギー密度および出力密度のいずれをも増大させることができる。

【0017】

【発明の実施の形態】＜実施形態例1＞以下、本発明にもとづくエネルギー貯蔵素子の一実施形態を図面を参照しながら説明する。

【0018】図1は、本発明にもとづくエネルギー貯蔵素子の一実施形態例である円筒型キャパシタの部分分解斜視図である。

【0019】円筒型キャパシタ1は、第1の電気二重層キャパシタ2と第2の電気二重層キャパシタ3とが積層して渦巻き状に巻き取られたキャパシタ積層体4と、螺旋状のキャパシタ積層体4を収納する容器5と、該容器5に注入された電解質溶液（不図示）とを有する。第1の電気二重層キャパシタ2および第2の電気二重層キャパシタ3は、それぞれ別々に、Al電極箔6およびCu電極箔7上にカーボンからなる層8、8′をそれぞれ成膜してなる一対のカーボン電気二重層電極9，10と、該電極間に介在したセパレータ11とから構成される。図に示すように、第1の電気二重層キャパシタ2と第2の電気二重層キャパシタ3とが、従来より知られている巻き取り法により巻き取られて、渦巻き状のキャパシタ積層体4を形成する。このキャパシタ積層体4は、円筒状の容器5に挿入されている。さらに、この円筒状の容器5には所定の濃度の有機電解液溶液が真空含浸法により注入され、また従来のかしめ法によりキャプが取り付けられている。

【0020】上記のようにして構成される本実施形態例の円筒型キャパシタ（以下、2層型キャパシタともいう）がエネルギー密度および出力密度の点で従来のものに比べて著しく優れたものであることを証明するために、以下のような比較例を用意した。すなわち、比較例として、第1の電気二重層キャパシタのみからなるエネルギー貯蔵素子（以下、1層型キャパシタともいう）を上記方法にしたがって作製した。また、2つの1層型キャパシタをリード線を介して電気的に積層した2個直列型キャパシタも比較例として構成した。これらの比較例と本実施形態例の2層型キャパシタとについて、それぞれのエネルギー密度および出力密度の特性を1層キャパシタに対する比の値にして表す。なおこれらの比は定電流充放電モードにおいてエネルギー密度が1／2になるときの電流に対する値である。

【0021】

【表1】

電気二重層キャパシタのエネルギー密度と出力密度の特性

キャパシタの種類	エネルギー密度の比	出力密度の比
2層型キャパシタ	1．25	1．47
2個直列型キャパシタ	0．98	0．96
1層型キャパシタ	1	1

【0022】明らかに2層型キャパシタがエネルギー密度も出力密度も優れていることがわかる。
【0023】＜実施形態例2＞実施形態例1のカーボン電気二重層電極の代わりに、$Ru(OH_3)\cdot XH_2O$の式で表されるルテニウム水酸化物を所定量担持したカーボンシート電極をAu箔に成膜していわゆる電気化学キャパシタ電極を形成した。以下、実施形態例1と同様にセパレータと交互に挟持して、当該電気化学キャパシタを2層積層して巻き取り、これを耐食性に優れる円筒缶に挿入して、硫酸電解液を真空含浸法で注入し、キャプ封入して2層キャパシタを形成した。表2に1層キャパシタとそれを2個リード線で電気的に積層した2個直列キャパシタと2層積層キャパシタのそれぞれのエネルギー密度と出力密度の特性を1層キャパシタに対する比で示す。
【0024】
【表2】
電気化学キャパシタのエネルギー密度と出力密度の特性

キャパシタの種類	エネルギー密度の比	出力密度の比
2層型キャパシタ	1．43	1．64
2個直列型キャパシタ	0．99	0．97
1層型キャパシタ	1	1

【0025】このように電気化学キャパシタを採用した場合でも、本実施形態例の2層型キャパシタがエネルギー密度および出力密度のいずれの特性においても従来のものよりも格段と優れていることがわかる。
【0026】なお、上記実施形態例1または2ではエネルギー貯蔵素子の形態を円筒形とし、また電気二重層キャパシタの数を2層とした。しかし、本発明はこれらの実施形態例に限定されるものではなく、例えば図2に示すように、エネルギー貯蔵素子の幅方向（または径方向）の断面形状を楕円形（図2（a））、三角形（図2（b））、正方形（図2（c））、あるいは五角形、六角形等の多角形にすることができる。また、電気二重層キャパシタを3層以上積層することも可能である。また、図2中、参照符号21、22、および23はそれぞれ3層以上積層してなるキャパシタ積層体を示す。このように、複数層の巻き取りが可能ならば、より高エネルギー密度かつ高出力密度のキャパシタが提供できることは自明である。
【0027】以上の実施形態例から明らかなように、本発明にもとづくエネルギー貯蔵素子は、非水溶媒系の有機電解質を用いた電気二重層キャパシタおよび硫酸電解液を用いた電気化学キャパシタのいずれの電極を採用しても、従来の構成（例えば、1層キャパシタを電気的に2個直列したキャパシタ）と比較して、エネルギー密度および出力密度の特性が著しく優れている。

【0028】本質的に水溶液系電解液に比較してエネルギー密度に優れる非水溶媒系の有機電解液を用いたエネルギー貯蔵素子は、従来では積層することができないため高電圧の高出力にいわゆる単セルを複数電気的に電流リード線同士で直列接続するしかなく、それゆえ電流リード線同士の接続抵抗増大等のため高出力が得られなかった。しかし、上記実施形態例に示したような構成を取ることによって、エネルギー密度に優れる非水溶媒系の有機電解液を用いた電気二重層キャパシタの積層化が可能となり、高エネルギー密度のみならず高出力密度の優れたエネルギー貯蔵素子を提供することが可能となる。
【0029】
【発明の効果】以上説明したように、本発明にもとづくエネルギー貯蔵素子は、上記のように構成されることによって、複数の電極対を巻き取ることにより複数セルの積層化ができ、かつ巻き取りにより電極の大面積化が達成される一方で、内部抵抗の増大が抑制される。その結果、原理的にエネルギー密度および出力密度のいずれをも増大させることができる。

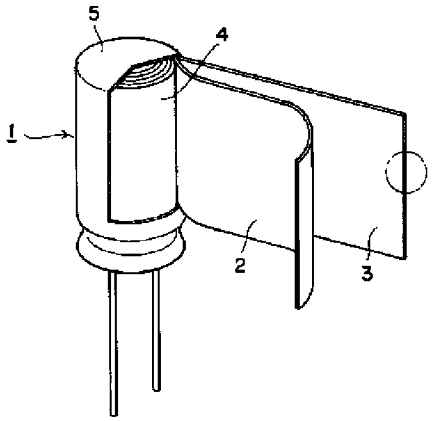
図の説明

【図面の簡単な説明】
【図1】本発明にもとづくエネルギー貯蔵素子の一実施形態例である円筒型キャパシタ示すもので、(a)はその部分分解斜視図、また(b)は(a)の中で破線で囲った部分の断面図である。
【図2】本発明にもとづくエネルギー貯蔵素子の他の実施形態例を示す斜視図であり、(a)ないし(c)は幅方向(または径方向)の断面形状がそれぞれ異なる。
【図3】従来の円筒型電気二重層キャパシタの部分分解斜視図である。
【符号の説明】
1 円筒型キャパシタ
2 第1の電気二重層キャパシタ層
3 第2の電気二重層キャパシタ層
4 キャパシタ積層体
5 容器
6 Al電極箔
7 Cu電極箔
8 カーボンからなる層
9、10 カーボン電気二重層電極
11 セパレータ

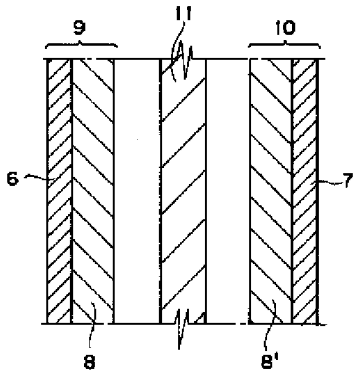
図面

【図1】

(a)

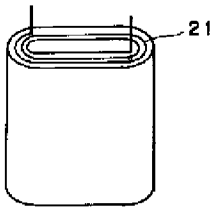


(b)



【図2】

(a)



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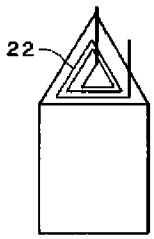
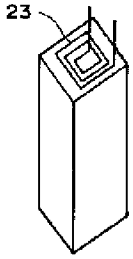
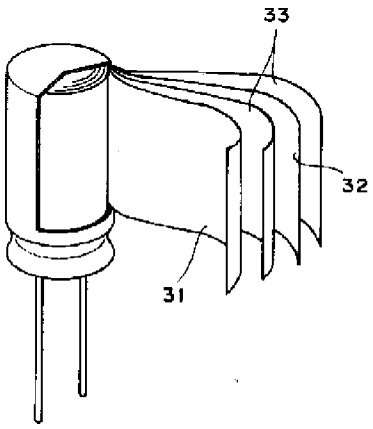


(c)



【図3】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PATENT ABSTRACTS OF JAPAN

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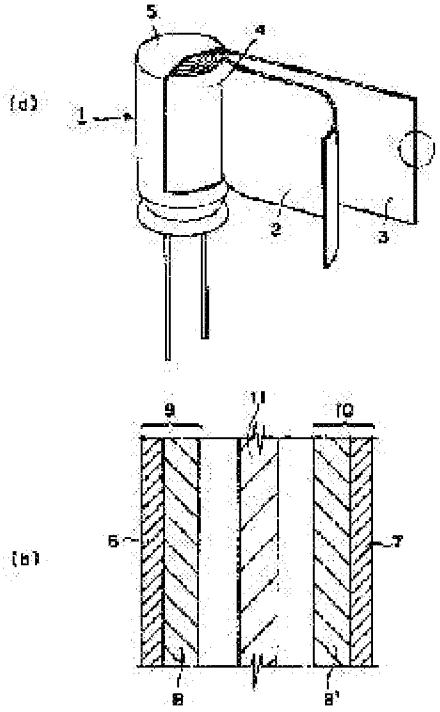
(54) **ENERGY-STORING ELEMENT**



(57)Abstract:
PROBLEM TO BE SOLVED: To improve both the energy density and output density of an energy- storing element by constituting the element of a wound laminated electric double layer capacitor, which is formed by laminating a plurality of electric double layer capacitors, each having two electrodes faced oppositely to each other through a separator and an electrolytic solution in which the electrodes are dipped upon another and spirally winding the laminate.
SOLUTION: A cylindrical capacitor 1, which is used as an energy storing element is constituted of a laminated capacitor body 4 which is formed by laminating first and second electric double layer capacitors 2 and 3 upon another and spirally winding the laminate, a container 5 housing the spiral capacitor laminate 4, and an electrolytic solution injected into the container 5. Each capacitor 2 and 3 is constituted of a pair of carbon electric double layer electrodes 9 and 10, which are respectively formed by forming carbon layers 8 and 8' on Al electrode foil 6 and Cu electrode foil 7 and a separator 11 interposed between the electrodes 9 and 10.

CLAIMS

[Claim(s)]
[Claim 1]An energy storage element, wherein it has a capacitor layered product characterized by comprising the following to which the plural laminates of the electric

double layer capacitor were carried out and said capacitor layered product consists of two or more electric double layer capacitors wound spirally.
Two electrodes which counter via a separator.
An electrolysis solution in which this electrode was dipped.

[Claim 2]The energy storage element according to claim 1, wherein said electrolysis solution is organic electrolysis liquid of a nonaqueous solvent system.
[Claim 3]The energy storage element according to claim 1, wherein said electrolysis solution is aqueous electrolysis liquid of a drainage system.
[Claim 4]The energy storage element according to any one of claims 1 to 3, wherein each of said two electrodes is a carbon electric double layer electrode.
[Claim 5]The energy storage element according to any one of claims 1 to 3, wherein each of said two electrodes is an electrochemical capacitor electrode.
[Claim 6]The energy storage element according to claim 5, wherein said electrochemical capacitor electrode is a carbon-sheet electrode which supported ruthenium hydroxide expressed with a formula of $Ru(OH)_3$ and XH_2O.
[Claim 7]The energy storage element according to any one of claims 1 to 6, wherein sectional shape of said capacitor layered product is any one shape of a cylindrical shape, an ellipse form, and the polygon.

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention]The energy storage element which this invention belongs to the field about storage of electrical energy, and attracts attention as a hybrid power supply with the cell for electromobiles especially, It is related with an usable energy storage element and the still more nearly usable energy storage element as an emergency power source or a backup power supply of IC or a memory combining a fuel cell, a solar cell, etc.
[0002]
[Description of the Prior Art]In recent years, it is prevention of the effective use of energy and environmental destruction as SUBJECT which must tackle by global. Especially environmental destruction of mass consumption of the fossil fuel accompanying development of an automobile industry, the air pollution by exhaust gas, etc. poses a serious problem. The not a problem but global measure which can solve such a problem on one company or an one-country level are demanded day by day.
[0003]The advanced nations which include Japan at least are advancing the measure for effective use of energy, reexamination of energy-saving technology and new technical development, and also the prevention from environmental destruction regardless of inside and outside and government and people. Development of the electromobile which being observed in recent years drives as an example of such technical development only with the hybrid electric vehicle which combined the gasoline engine and the electric motor, or an electric motor, Development of the ice thermal storage art which aimed at effective use of the night power in a city part, development of a fuel cell with high generation efficiency which is excellent in environment nature, and development of the solar cell

which exploited solar energy further can be mentioned.
[0004]By the way, in a hybrid electric vehicle or an electromobile, a battery is used as a storage power supply of electrical energy. However, it cannot say that the power density characteristic of that a battery excels [that] in energy density characteristics is enough, but using for the power supply system of an electromobile the capacitor which excels a battery in the power density characteristic combining a battery is proposed.
[0005]What is called an electric double layer capacitor uses capacity with a big electric double layer produced in the interface of an electrode and an electrolysis solution, and takes the electric charge of this double layer like the charge and discharge of a cell. There are a thing of an organic solvent system and a thing of an aqueous solution system in an electrolysis solution.
[0006]Drawing 3 is a partial decomposition perspective view of a typical cylindrical electric double layer capacitor more publicly known than before. A corrosion-resistant electrolysis solution is used for this capacitor, it winds the electrode of a couple, and uses it as a cylindrical shape. That is, the filmy electrode layered product which made the separator 33 which consists of porous membrane made from polyethylene or polypropylene between the filmy anode 31 fabricated with material with big surface area like activated carbon and binders, such as a fluoro-resin, and the filmy negative pole 32 fabricated similarly pinch is wound. Thus, by making it spiral, the surface area of the electrode occupied in a capacitor becomes large, and the internal resistance of a capacitor becomes small in inverse proportion to it. As a result, ionic conductivity can also use a large nonaqueous solvent system electrolysis solution for an electrolysis solution with a beam as compared with an aqueous solution system electrolysis solution. Since the decomposition voltage of the solvent of this nonaqueous solvent system electrolysis solution is high more generally than the decomposition voltage of the water which is a solvent of an aqueous solution system electrolysis solution, the capacitor using a nonaqueous solvent system electrolysis solution can make that part energy density larger than the capacitor which used the aqueous solution system electrolysis solution. By the way, the capacitor of the monotonous lamination type instead of a cylindrical shape is also known from the former. However, as for the capacitor of a monotonous lamination type, while capacitor voltage becomes large in proportion to the number of laminations of a cell, the internal resistance by an electrolysis solution will also become large in proportion to the number of laminations. For this reason, in a monotonous lamination type capacitor, since ionic conductivity cannot use a small nonaqueous solvent system electrolysis solution with a beam as compared with an aqueous solution system electrolysis solution, an aqueous solution system electrolysis solution is mainly used, and much package-ization of a cell is attained by it. However, as already stated, since the decomposition voltage of an aqueous solution system electrolysis solution is lower than a nonaqueous solvent system electrolysis solution, this monotonous lamination type has that part and the problem that an energy density becomes small theoretically.
[0007]Thus, the conventional capacitor can be said to be that the structure of a capacitor is decided by whether the electrolysis solution is an aqueous solution system or a nonaqueous solvent liquid system. It is as follows when each feature of this rolled-round type and a monotonous lamination type is compared. That is, in a rolled-round type, since a nonaqueous solvent liquid system electrolysis solution is used as already stated, there are no worries about the corrosion of the metal cylinder can (generally aluminum is used

for the material of a cylinder can) by an electrolysis solution, and it is easily attained by whether a seal is mechanical in a cylinder can, and the method of enclosing in total. Conversely, since an aqueous solution system electrolysis solution corrodes a metal cylinder can, this is not usually used. On the other hand, an aqueous solution system electrolysis solution is extraordinarily cheap as compared with a nonaqueous solvent liquid system electrolysis solution, in order that the monotonous lamination type using it may laminate two or more cells, there are few member mark as compared with what carried out the series connection of cylindrical [single cell type] to the same number electrical-and-electric-equipment target, and it can be expected that the part will also serve as low cost. However, since an aqueous solution system electrolysis solution has corrosiveness, metal electrodes, such as aluminum, cannot be used for an electrode, but carbon is usually used. As for the seal of an electrolysis solution, resin molding-ization for every lamination cell round head is usually made. Therefore, it is not clear which type is advantageous in cost. Although the high power of high tension and a high current can expect a monotonous lamination type theoretically, Although the series connection of two or more them will be carried out electrically and the internal resistance by an electrolysis solution is ending with a measure in large area-ization of an electrode, a rolled-round type (cylindrical), The connection resistance of electric leads increases and it becomes impossible to expect high power density in the case where rolled round as compared with the monotonous lamination type, and two or more molds (cylindrical) are connected.

[0008]

[Problem(s) to be Solved by the Invention]Thus, in both cases, a conventional cylindrical capacitor and monotonous lamination type capacitor have merits and demerits. Namely, the laminated structure of the electrode applied to a cylindrical capacitor with high decomposition voltage of an electrolysis solution and a separator, Although an energy density is high, since resistance of an electrolysis solution is strong, monotonous lamination is difficult and power density is inferior in it by connection resistance increase of electrode lead lines, etc. also as composition to which two or more these cylindrical capacitors are connected. On the other hand, although a monotonous lamination type capacitor excels a cylindrical capacitor in power density, an energy density is inferior to a part with low decomposition voltage of an electrolysis solution, and a cylindrical thing in it.

[0009]Therefore, this invention solves an aforementioned problem and that [any] of an energy density and power density is aimed at providing the new energy storage element which is excellent in a principle target.

[0010]

[Means for Solving the Problem]In order to solve an aforementioned problem, an energy storage element based on this invention, It has a capacitor layered product to which the plural laminates of the electric double layer capacitor which has two electrodes which counter via a separator, and the electric field liquid in which this electrode was dipped were carried out, and said capacitor layered product consists of two or more electric double layer capacitors wound spirally.

[0011]Preferably, said electrolysis solution is organic electrolysis liquid of a nonaqueous solvent system, or aqueous electrolysis liquid of a drainage system.

[0012]Preferably, each of said two electrodes is a carbon electric double layer electrode.

[0013]Preferably, each of said two electrodes is an electrochemical capacitor electrode.

[0014]Preferably, said electrochemical capacitor electrode is a carbon-sheet electrode which supported ruthenium hydroxide expressed with a formula of $Ru(OH)_3$ and XH_2O.
[0015]Preferably, sectional shape of said capacitor layered product is any one shape of a cylindrical shape, an ellipse form, and the polygon.
[0016]While lamination of two or more cells can be performed and large area-ization of an electrode is maintained by rolling up by rolling round two or more electrode pairs, increase of internal resistance is controlled. As a result, both an energy density and power density can be increased theoretically.
[0017]
[Embodiment of the Invention]Below the <example 1 of an embodiment> describes one embodiment of an energy storage element based on this invention, referring to drawings.
[0018]Drawing 1 is a partial decomposition perspective view of the cylindrical capacitor which is an example of 1 embodiment of an energy storage element based on this invention.
[0019]The cylindrical capacitor 1 is provided with the following.
The capacitor layered product 4 which the 1st electric double layer capacitor 2 and 2nd electric double layer capacitor 3 laminated, and was rolled round spirally.
The container 5 which stores the spiral capacitor layered product 4.
The electrolytic solution poured into this container 5 (un-illustrating).
The 1st electric double layer capacitor 2 and 2nd electric double layer capacitor 3, It comprises independently the layer 8 which consists of carbon on the Al electrode foil 6 and the Cu electrode foil 7, the carbon electric double layer electrodes 9 and 10 of the couple which forms 8', respectively, and the separator 11 by which it was placed between this inter-electrode one, respectively. As shown in a figure, the 1st electric double layer capacitor 2 and 2nd electric double layer capacitor 3 are rolled round by the rolling-round method known conventionally, and form the spiral capacitor layered product 4. This capacitor layered product 4 is inserted in the cylindrical container 5. The organic electrolysis liquid solution of predetermined concentration is poured into this cylindrical container 5 by vacuum impregnation, and you make it go away conventionally, and KYAPU is attached by law.
[0020]In order to prove that the cylindrical capacitor (henceforth a two-layer type capacitor) of this example of an embodiment constituted as mentioned above is remarkably excellent in the point of an energy density and power density compared with the conventional thing, the following comparative examples were prepared. That is, the energy storage element (henceforth an one-layer type capacitor) which consists only of the 1st electric double layer capacitor was produced in accordance with the described method as a comparative example. The two-piece tandem-type capacitor which laminated two one-layer type capacitors electrically via the lead was also constituted as a comparative example. About the two-layer type capacitor of these comparative examples and this example of an embodiment, the characteristic of each energy density and power density is made into the value of the ratio to an one-layer capacitor, and it expresses. These ratios are the values to current in case an energy density is set to one half in constant current charge and discharge mode.
[0021]
[Table 1]

電気二重層キャパシタのエネルギー密度と出力密度の特性

キャパシタの種類	エネルギー密度の比	出力密度の比
2層型キャパシタ	1．25	1．47
2個直列型キャパシタ	0．98	0．96
1層型キャパシタ	1	1

[0022]It turns out that the two-layer type capacitor is clearly excellent also in an energy density and power density.
[0023]The carbon-sheet electrode which carried out specified quantity support of the ruthenium hydroxide expressed with the formula of Ru (OH_3) and XH_2O instead of the carbon electric double layer electrode of the example 1 of the <example 2 of embodiment> embodiment was formed to Au foil, and what is called an electrochemical capacitor electrode was formed. It pinched a separator and by turns like the example 1 of an embodiment hereafter, and two-layer lamination was carried out, the electrochemical capacitor concerned was rolled round, this was inserted in the cylinder can which is excellent in corrosion resistance, the sulfuric acid electrolysis solution was poured in by vacuum impregnation, KYAPU enclosure was carried out, and the two-layer capacitor was formed. The characteristic of each energy density and power density of an one-layer capacitor, the two-piece in-series capacitor which laminated it electrically with a two-piece lead, and a two-layer laminated capacitor is shown in Table 2 by the ratio to an one-layer capacitor.
[0024]
[Table 2]
電気化学キャパシタのエネルギー密度と出力密度の特性

キャパシタの種類	エネルギー密度の比	出力密度の比
2層型キャパシタ	1．43	1．64
2個直列型キャパシタ	0．99	0．97
1層型キャパシタ	1	1

[0025]Thus, even when an electrochemical capacitor is adopted, it turns out that the two-layer type capacitor of this example of an embodiment is markedly superior to the

conventional thing also in which characteristic of an energy density and power density.
[0026]In the above-mentioned example 1 or 2 of an embodiment, the gestalt of the energy storage element was used as the cylindrical shape, and the number of electric double layer capacitors was made two-layer. However, as this invention is not limited to these examples of an embodiment and shown, for example in drawing 2, Sectional shape of the cross direction (or diameter direction) of an energy storage element can be made into polygons, such as an ellipse form (drawing 2 (a)), a triangle (drawing 2 (b)), a square (drawing 2 (c)) or a pentagon, and a hexagon. It is also possible to laminate three or more layers of electric double layer capacitors. The reference marks 21, 22, and 23 show the capacitor layered product laminated three or more layers, respectively among drawing 2. Thus, if rolling up of two or more layers is possible, it is obvious that the capacitor of high energy density and high power density can be provided more.
[0027]The energy storage element based on this invention so that clearly from the above example of an embodiment, Even if it adopts which electrode of the electrochemical capacitor using the electric double layer capacitor and sulfuric acid electrolysis solution using an organic electrolyte of a nonaqueous solvent system, As compared with the conventional composition (for example, capacitor which carried out the two-piece series of the one-layer capacitor electrically), the characteristic of an energy density and power density is remarkably excellent.
[0028]The energy storage element using the organic electrolysis liquid of a nonaqueous solvent system which is intrinsically excellent in an energy density as compared with an aqueous solution system electrolysis solution, In the former, since it was not able to laminate, the series connection what is called of two or more single cells had to be electrically carried out to the high power of high tension by current lead lines, and so, high power was not obtained for connection resistance increase of current lead lines, etc. However, by taking composition as shown in the above-mentioned example of an embodiment, lamination of the electric double layer capacitor using the organic electrolysis liquid of a nonaqueous solvent system which is excellent in an energy density is attained, and it becomes possible to provide the energy storage element which was excellent not only in high energy density but high power density.
[0029]
[Effect of the Invention]As explained above, while the energy storage element based on this invention can perform lamination of two or more cells by rolling round two or more electrode pairs by being constituted as mentioned above and large area-ization of an electrode is attained by rolling up, increase of internal resistance is controlled. As a result, both an energy density and power density can be increased theoretically.

TECHNICAL FIELD

[Field of the Invention]The energy storage element which this invention belongs to the field about storage of electrical energy, and attracts attention as a hybrid power supply with the cell for electromobiles especially, It is related with an usable energy storage element and the still more nearly usable energy storage element as an emergency power source or a backup power supply of IC or a memory combining a fuel cell, a solar cell, etc.

PRIOR ART

[Description of the Prior Art]In recent years, it is prevention of the effective use of energy and environmental destruction as SUBJECT which must tackle by global. Especially environmental destruction of mass consumption of the fossil fuel accompanying development of an automobile industry, the air pollution by exhaust gas, etc. poses a serious problem. The not a problem but global measure which can solve such a problem on one company or an one-country level are demanded day by day.

[0003]The advanced nations which include Japan at least are advancing the measure for effective use of energy, reexamination of energy-saving technology and new technical development, and also the prevention from environmental destruction regardless of inside and outside and government and people. Development of the electromobile which being observed in recent years drives as an example of such technical development only with the hybrid electric vehicle which combined the gasoline engine and the electric motor, or an electric motor, Development of the ice thermal storage art which aimed at effective use of the night power in a city part, development of a fuel cell with high generation efficiency which is excellent in environment nature, and development of the solar cell which exploited solar energy further can be mentioned.

[0004]By the way, in a hybrid electric vehicle or an electromobile, a battery is used as a storage power supply of electrical energy. However, it cannot say that the power density characteristic of that a battery excels [that] in energy density characteristics is enough, but using for the power supply system of an electromobile the capacitor which excels a battery in the power density characteristic combining a battery is proposed.

[0005]What is called an electric double layer capacitor uses capacity with a big electric double layer produced in the interface of an electrode and an electrolysis solution, and takes the electric charge of this double layer like the charge and discharge of a cell. There are a thing of an organic solvent system and a thing of an aqueous solution system in an electrolysis solution.

[0006]Drawing 3 is a partial decomposition perspective view of a typical cylindrical electric double layer capacitor more publicly known than before. A corrosion-resistant electrolysis solution is used for this capacitor, it winds the electrode of a couple, and uses it as a cylindrical shape. That is, the filmy electrode layered product which made the separator 33 which consists of porous membrane made from polyethylene or polypropylene between the filmy anode 31 fabricated with material with big surface area like activated carbon and binders, such as a fluoro-resin, and the filmy negative pole 32 fabricated similarly pinch is wound. Thus, by making it spiral, the surface area of the electrode occupied in a capacitor becomes large, and the internal resistance of a capacitor becomes small in inverse proportion to it. As a result, ionic conductivity can also use a large nonaqueous solvent system electrolysis solution for an electrolysis solution with a beam as compared with an aqueous solution system electrolysis solution. Since the decomposition voltage of the solvent of this nonaqueous solvent system electrolysis solution is high more generally than the decomposition voltage of the water which is a solvent of an aqueous solution system electrolysis solution, the capacitor using a nonaqueous solvent system electrolysis solution can make that part energy density larger than the capacitor which used the aqueous solution system electrolysis solution. By the way, the capacitor of the monotonous lamination type instead of a cylindrical shape is

also known from the former. However, as for the capacitor of a monotonous lamination type, while capacitor voltage becomes large in proportion to the number of laminations of a cell, the internal resistance by an electrolysis solution will also become large in proportion to the number of laminations. For this reason, in a monotonous lamination type capacitor, since ionic conductivity cannot use a small nonaqueous solvent system electrolysis solution with a beam as compared with an aqueous solution system electrolysis solution, an aqueous solution system electrolysis solution is mainly used, and much package-ization of a cell is attained by it. However, as already stated, since the decomposition voltage of an aqueous solution system electrolysis solution is lower than a nonaqueous solvent system electrolysis solution, this monotonous lamination type has that part and the problem that an energy density becomes small theoretically.

[0007]Thus, the conventional capacitor can be said to be that the structure of a capacitor is decided by whether the electrolysis solution is an aqueous solution system or a nonaqueous solvent liquid system. It is as follows when each feature of this rolled-round type and a monotonous lamination type is compared. That is, in a rolled-round type, since a nonaqueous solvent liquid system electrolysis solution is used as already stated, there are no worries about the corrosion of the metal cylinder can (generally aluminum is used for the material of a cylinder can) by an electrolysis solution, and it is easily attained by whether a seal is mechanical in a cylinder can, and the method of enclosing in total. Conversely, since an aqueous solution system electrolysis solution corrodes a metal cylinder can, this is not usually used. On the other hand, an aqueous solution system electrolysis solution is extraordinarily cheap as compared with a nonaqueous solvent liquid system electrolysis solution, in order that the monotonous lamination type using it may laminate two or more cells, there are few member mark as compared with what carried out the series connection of cylindrical [single cell type] to the same number electrical-and-electric-equipment target, and it can be expected that the part will also serve as low cost. However, since an aqueous solution system electrolysis solution has corrosiveness, metal electrodes, such as aluminum, cannot be used for an electrode, but carbon is usually used. As for the seal of an electrolysis solution, resin molding-ization for every lamination cell round head is usually made. Therefore, it is not clear which type is advantageous in cost. Although the high power of high tension and a high current can expect a monotonous lamination type theoretically, Although the series connection of two or more them will be carried out electrically and the internal resistance by an electrolysis solution is ending with a measure in large area-ization of an electrode, a rolled-round type (cylindrical), The connection resistance of electric leads increases and it becomes impossible to expect high power density in the case where rolled round as compared with the monotonous lamination type, and two or more molds (cylindrical) are connected.

EFFECT OF THE INVENTION

[Effect of the Invention]As explained above, while the energy storage element based on this invention can perform lamination of two or more cells by rolling round two or more electrode pairs by being constituted as mentioned above and large area-ization of an electrode is attained by rolling up, increase of internal resistance is controlled. As a result, both an energy density and power density can be increased theoretically.

TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention]Thus, in both cases, a conventional cylindrical capacitor and monotonous lamination type capacitor have merits and demerits. Namely, the laminated structure of the electrode applied to a cylindrical capacitor with high decomposition voltage of an electrolysis solution and a separator, Although an energy density is high, since resistance of an electrolysis solution is strong, monotonous lamination is difficult and power density is inferior in it by connection resistance increase of electrode lead lines, etc. also as composition to which two or more these cylindrical capacitors are connected. On the other hand, although a monotonous lamination type capacitor excels a cylindrical capacitor in power density, an energy density is inferior to a part with low decomposition voltage of an electrolysis solution, and a cylindrical thing in it.

[0009]Therefore, this invention solves an aforementioned problem and that [any] of an energy density and power density is aimed at providing the new energy storage element which is excellent in a principle target.

MEANS

[Means for Solving the Problem]In order to solve an aforementioned problem, an energy storage element based on this invention, It has a capacitor layered product to which the plural laminates of the electric double layer capacitor which has two electrodes which counter via a separator, and the electric field liquid in which this electrode was dipped were carried out, and said capacitor layered product consists of two or more electric double layer capacitors wound spirally.

[0011]Preferably, said electrolysis solution is organic electrolysis liquid of a nonaqueous solvent system, or aqueous electrolysis liquid of a drainage system.

[0012]Preferably, each of said two electrodes is a carbon electric double layer electrode.

[0013]Preferably, each of said two electrodes is an electrochemical capacitor electrode.

[0014]Preferably, said electrochemical capacitor electrode is a carbon-sheet electrode which supported ruthenium hydroxide expressed with a formula of $Ru(OH)_3$ and XH_2O.

[0015]Preferably, sectional shape of said capacitor layered product is any one shape of a cylindrical shape, an ellipse form, and the polygon.

[0016]While lamination of two or more cells can be performed and large area-ization of an electrode is maintained by rolling up by rolling round two or more electrode pairs, increase of internal resistance is controlled. As a result, both an energy density and power density can be increased theoretically.

[0017]

[Embodiment of the Invention]Below the <example 1 of an embodiment> describes one embodiment of an energy storage element based on this invention, referring to drawings.

[0018]Drawing 1 is a partial decomposition perspective view of the cylindrical capacitor which is an example of 1 embodiment of an energy storage element based on this invention.

[0019]The cylindrical capacitor 1 is provided with the following.

The capacitor layered product 4 which the 1st electric double layer capacitor 2 and 2nd electric double layer capacitor 3 laminated, and was rolled round spirally.
The container 5 which stores the spiral capacitor layered product 4.
The electrolytic solution poured into this container 5 (un-illustrating).
The 1st electric double layer capacitor 2 and 2nd electric double layer capacitor 3, It comprises independently the layer 8 which consists of carbon on the Al electrode foil 6 and the Cu electrode foil 7, the carbon electric double layer electrodes 9 and 10 of the couple which forms 8', respectively, and the separator 11 by which it was placed between this inter-electrode one, respectively. As shown in a figure, the 1st electric double layer capacitor 2 and 2nd electric double layer capacitor 3 are rolled round by the rolling-round method known conventionally, and form the spiral capacitor layered product 4. This capacitor layered product 4 is inserted in the cylindrical container 5. The organic electrolysis liquid solution of predetermined concentration is poured into this cylindrical container 5 by vacuum impregnation, and you make it go away conventionally, and KYAPU is attached by law.
[0020]In order to prove that the cylindrical capacitor (henceforth a two-layer type capacitor) of this example of an embodiment constituted as mentioned above is remarkably excellent in the point of an energy density and power density compared with the conventional thing, the following comparative examples were prepared. That is, the energy storage element (henceforth an one-layer type capacitor) which consists only of the 1st electric double layer capacitor was produced in accordance with the described method as a comparative example. The two-piece tandem-type capacitor which laminated two one-layer type capacitors electrically via the lead was also constituted as a comparative example. About the two-layer type capacitor of these comparative examples and this example of an embodiment, the characteristic of each energy density and power density is made into the value of the ratio to an one-layer capacitor, and it expresses. These ratios are the values to current in case an energy density is set to one half in constant current charge and discharge mode.
[0021]
[Table 1]
電気二重層キャパシタのエネルギー密度と出力密度の特性

キャパシタの種類	エネルギー密度の比	出力密度の比
2層型キャパシタ	1．25	1．47
2個直列型キャパシタ	0．98	0．96
1層型キャパシタ	1	1

[0022]It turns out that the two-layer type capacitor is clearly excellent also in an energy density and power density.
[0023]The carbon-sheet electrode which carried out specified quantity support of the

ruthenium hydroxide expressed with the formula of Ru (OH_3) and XH_2O instead of the carbon electric double layer electrode of the example 1 of the <example 2 of embodiment> embodiment was formed to Au foil, and what is called an electrochemical capacitor electrode was formed. It pinched a separator and by turns like the example 1 of an embodiment hereafter, and two-layer lamination was carried out, the electrochemical capacitor concerned was rolled round, this was inserted in the cylinder can which is excellent in corrosion resistance, the sulfuric acid electrolysis solution was poured in by vacuum impregnation, KYAPU enclosure was carried out, and the two-layer capacitor was formed. The characteristic of each energy density and power density of an one-layer capacitor, the two-piece in-series capacitor which laminated it electrically with a two-piece lead, and a two-layer laminated capacitor is shown in Table 2 by the ratio to an one-layer capacitor.

[0024]

[Table 2]

電気化学キャパシタのエネルギー密度と出力密度の特性

キャパシタの種類	エネルギー密度の比	出力密度の比
2層型キャパシタ	1．43	1．64
2個直列型キャパシタ	0．99	0．97
1層型キャパシタ	1	1

[0025]Thus, even when an electrochemical capacitor is adopted, it turns out that the two-layer type capacitor of this example of an embodiment is markedly superior to the conventional thing also in which characteristic of an energy density and power density.

[0026]In the above-mentioned example 1 or 2 of an embodiment, the gestalt of the energy storage element was used as the cylindrical shape, and the number of electric double layer capacitors was made two-layer. However, as this invention is not limited to these examples of an embodiment and shown, for example in drawing 2, Sectional shape of the cross direction (or diameter direction) of an energy storage element can be made into polygons, such as an ellipse form (drawing 2 (a)), a triangle (drawing 2 (b)), a square (drawing 2 (c)) or a pentagon, and a hexagon. It is also possible to laminate three or more layers of electric double layer capacitors. The reference marks 21, 22, and 23 show the capacitor layered product laminated three or more layers, respectively among drawing 2. Thus, if rolling up of two or more layers is possible, it is obvious that the capacitor of high energy density and high power density can be provided more.

[0027]The energy storage element based on this invention so that clearly from the above example of an embodiment, Even if it adopts which electrode of the electrochemical capacitor using the electric double layer capacitor and sulfuric acid electrolysis solution using an organic electrolyte of a nonaqueous solvent system, As compared with the conventional composition (for example, capacitor which carried out the two-piece series

of the one-layer capacitor electrically), the characteristic of an energy density and power density is remarkably excellent.
[0028]The energy storage element using the organic electrolysis liquid of a nonaqueous solvent system which is intrinsically excellent in an energy density as compared with an aqueous solution system electrolysis solution, In the former, since it was not able to laminate, the series connection what is called of two or more single cells had to be electrically carried out to the high power of high tension by current lead lines, and so, high power was not obtained for connection resistance increase of current lead lines, etc. However, by taking composition as shown in the above-mentioned example of an embodiment, lamination of the electric double layer capacitor using the organic electrolysis liquid of a nonaqueous solvent system which is excellent in an energy density is attained, and it becomes possible to provide the energy storage element which was excellent not only in high energy density but high power density.

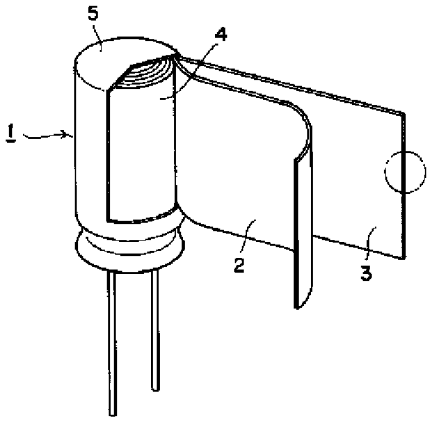
DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1]It is a cylindrical capacitor **** thing which is an example of 1 embodiment of an energy storage element based on this invention, and is a sectional view of the portion which enclosed (a) with the partial decomposition perspective view, and enclosed (b) with the dashed line in (a).
[Drawing 2]It is a perspective view showing other examples of an embodiment of an energy storage element based on this invention, and crosswise (or diameter direction) sectional shape differs between (a) thru/or (c), respectively.
[Drawing 3]It is a partial decomposition perspective view of the conventional cylindrical electric double layer capacitor.
[Description of Notations]
1 Cylindrical capacitor
2 The 1st electric double layer capacitor layer
3 The 2nd electric double layer capacitor layer
4 Capacitor layered product
5 Container
6 Al electrode foil
7 Cu electrode foil
8 The layer which consists of carbon
9 and 10 Carbon electric double layer electrode
11 Separator

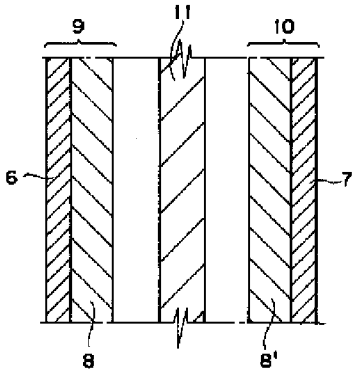
DRAWINGS

[Drawing 1]

(a)

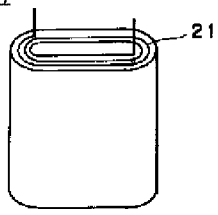


(b)

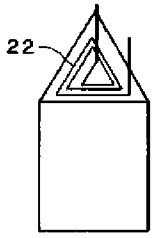


[Drawing 2]

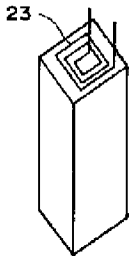
(a)



(b)



(c)



[Drawing 3]